MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2016/2017

ETM7226 – ANTENNA AND ELECTROMAGNETIC COMPATIBILITY

4 MARCH 2017
9.00 a.m - 12.00 p.m
(3 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 5 pages with 4 questions only.

2. Answer **ALL FOUR** questions, all questions carry equal marks of 25. The distribution of the marks for each question is given.

3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) The radiation intensity of an antenna is given by:

$$U(\theta,\phi)=\begin{cases}2\sin\theta\sin^3\phi, & 0\le\theta\le\pi, 0\le\phi\le\pi\\ 0, & elsewhere\end{cases}$$

Calculate the directivity in this case. Note that (θ,ϕ) is the evelvation and azimuth angles of a spherical coordinate system.

[9 Marks]

(b) State the difference between an isotropic antenna and an omni-directional antenna.

[4 Marks]

(c) A 1-m long dipole antenna with input impedance of Z_{in} = 73 + j42 Ω is driven by a source having a source resistance of 50 Ω and a voltage of 100 V. If the ohmic resistance of the antenna is given by R_L = 0.625 Ω, determine the following:

(i) The current going into the antenna (I_{ant}).

[2 Marks]

(ii) The average power dissipated by the current.

[2 Marks]

(iii) The average power radiated by the antenna.

[2 Marks]

(iv) The radiation efficiency of the antenna.

[2 Marks]

(d) Give the definition of the following terms as applied to antennas:

(i) Beam solid angle

[2 Marks]

(ii) Gain

[2 Marks]

Question 2

(a) List **FIVE** (5) independent controls that can be used to set up an antenna array.

[5 Marks]

(b)

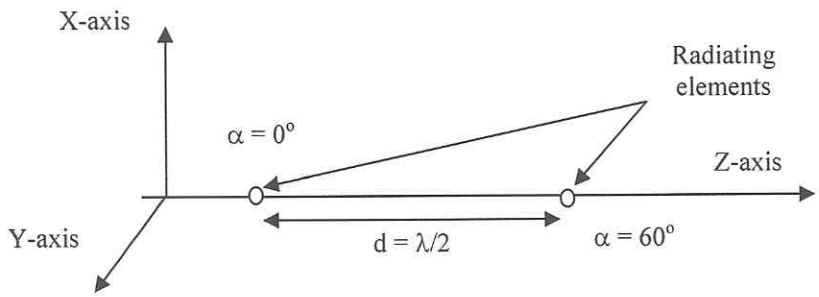

Figure Q2

An array is constructed with two radiating elements (isotropic sources) spaced half-wavelength apart ($d=\lambda/2$). The elements are arranged along the Z-axis, as shown in Figure Q2 above. The elements are fed with equal power and have a progressive phase shift (α) of 60° between them.

(i) Determine the array factor for this arrangement.

[6 Marks]

(ii) Calculate the pattern nulls and pattern maximum for this array.

[6 Marks]

(iii) Sketch the array pattern.

[8 Marks]

Question 3

(a) Explain the term Electromagnetic Compatibility (EMC). Identify the **THREE** (3) criteria for an electronic system to be considered electromagnetically compatible.

[5 Marks]

(b) Contrast the difference between *intersystem interference* and *intrasystem interference*. Give one example for each type of interference.

[4 Marks]

(c) Discuss the two aspects of EMC: Emission and Susceptibility.

[4 Marks]

(d) An Electromagnetic Interference (EMI) Filter is connected in between the board with interferences and spectrum analyzer as shown in Figure Q3.

(Assume that the connecting cables and connectors have no loss)

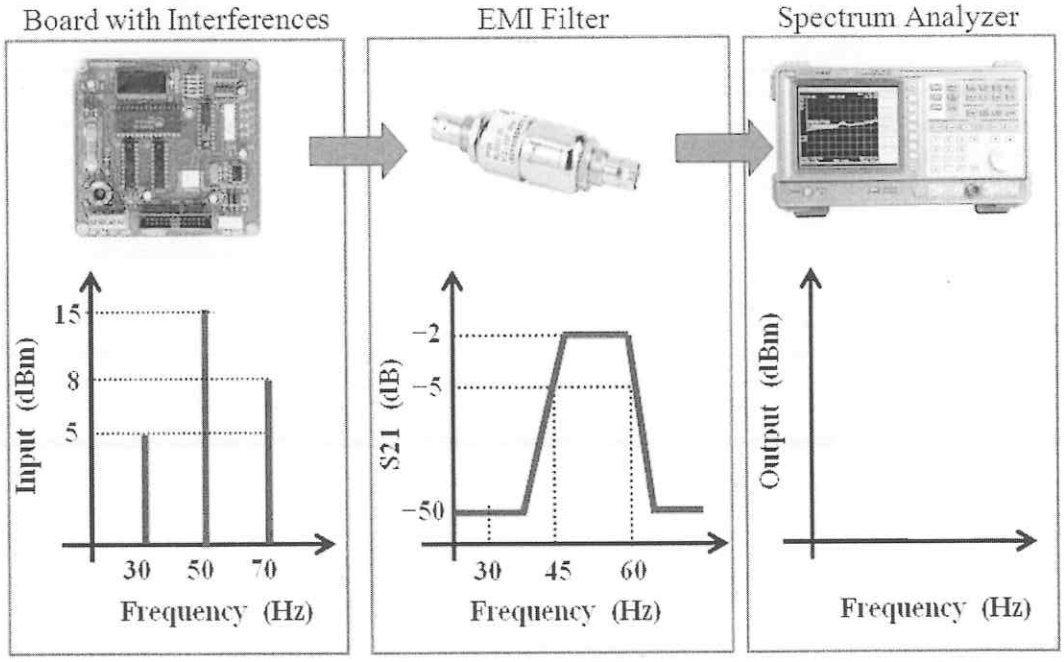

Figure Q3

(i) What is an EMI Filter?

[2 Marks]

(ii) What type of EMI filter is shown in the above measurement?

[2 Marks]

(iii) Determine the insertion loss, pass-band frequencies, cut-off frequencies and 3 dB bandwidth of the filter.

[4 Marks]

(iv) What are the stop-band frequency and rejection of the filter?

[2 Marks]

(v) Sketch the output of the spectrum analyzer in the graph above and indicate the frequency points and power level.

[2 Marks]

Question 4

(a) Consider three parallel wires, two are the signal leads (lead-1 and lead-2) and the third is a common signal-return lead (lead-G). The circuit of Figure Q4A represents the capacitive coupling between the circuits. Show that the noise voltage V_N can be expressed as:

$$V_N = \frac{j\omega A}{(j\omega)^2 + (j\omega)B + C} V_S$$

where A, B and C are a function of R_{1S}, R_{1L}, R_{2S}, R_{2L}, C_1, C_2 and C_G.

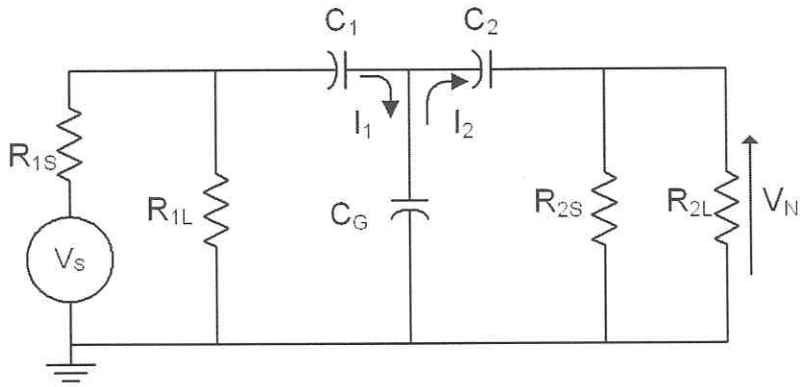

Figure Q4A

[11 Marks]

(b) Consider the PCB trace in Figure Q4B. Trace 1, 2 and 3 carries signal and the return is the ground plane. If Trace 1 is connected to input signal, derive the expression for the capacitive coupled noise at Trace 3. Assume the coupling occurs between trace 1 to 2 and from 2 to 3. There is no direct coupling between trace 1 and 3. Also assume the termination impedance on all traces are high.

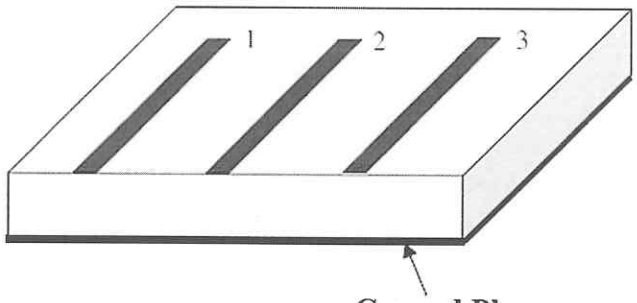

Figure Q4B

[7 Marks]

(c) Explain the functions and the deployment consideration of a common-mode choke.

[4 Marks]

(d) State **THREE (3)** techniques that can be applied to reduce inductive coupling between cables.

[3 Marks]

End of paper.